

GEOLOGY.—*Present Cretaceous stratigraphic nomenclature of northern Alaska.*¹

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Until 1944, geologic investigations in northern Alaska were of a reconnaissance nature and few stratigraphic units were recognized and named. Since 1944 the U. S. Geological Survey in cooperation with the U. S. Navy has been investigating the petroleum possibilities of Naval Petroleum Reserve No. 4. These investigations have covered nearly all northern Alaska from the Jago River west to the Kukpowruk River and from the Arctic Ocean south to and in several places into the Brooks Range (Fig. 1). This work has resulted in much more detailed information on the geology of the region. Rocks ranging in age from questionable pre-Cambrian to Pleistocene have been mapped and drilled. Cambrian, Ordovician, and Silurian rocks are not known to crop out north of the crest of the Brooks Range, but all other systems are represented (Fig. 2). To date the Cretaceous rocks have been studied more intensively than the rocks of any other age, and as a result a more detailed classification has been achieved (Fig. 3).

The Cretaceous rocks in the Anaktuvuk (Anaktoovuk) River area of northern Alaska were first described by Schrader.³ Smith and Mertie⁴ redefined the age of some of these rocks and added descriptions of their distribution and lithology. The present study has resulted in many changes in the stratigraphic classification. It is not always possible to tell from the literature what rocks have been included in previously described stratigraphic units and therefore these units may not be strictly comparable to the stratigraphic units introduced here. The apparent relationship of past and present stratigraphic nomenclature is shown in Table 1.

¹ Published by permission of the Director, U. S. Geological Survey.

² Authors listed in alphabetical order.

³ SCHRADER, F. C., *Geological section of the Rocky Mountains in northern Alaska*. Bull. Geol. Soc. Amer. **13**: 247. 1902.

⁴ SMITH, P. S., and MERTIE, J. B., JR., *Geology and mineral resources of northern Alaska*. Bull. U. S. Geol. Surv. **815**: 196-232. 1930.

The new classification is here presented and discussed. This classification is based on geologic field studies of the outcrop areas and on laboratory studies by the U. S. Geological Survey during the period 1944 to 1951.

CRETACEOUS ROCKS

Lower Cretaceous

OKPIKRUAK FORMATION (NEW)

The Okpikruak formation (new) is typically exposed along the Okpikruak River, from which it is named. The type section lies in the middle of a major syncline and is exposed on a small tributary of the Okpikruak River at about lat. 68°34'30"N. and long. 153°38'W. The formation crops out in the southern part of the Arctic Foothills province from the Itkillik River west to the Kukpowruk River. In the Arctic Foothills province, as far as known, it rests on Jurassic or Triassic rocks with little or no angular discordance. At its type locality it is about 2,400 feet thick. To date this is the greatest thickness measured, but an erosion surface between it and the overlying Torok formation indicates that it may be thicker elsewhere. It is predominantly fine-grained greenish-gray sandstone of the gray-wacke type, dark clay, and silt shale with minor amounts of conglomerate near the base. On the Siksikpuk River, where part of the formation is well exposed, it is 1,850 feet thick. Here it is characterized by a rhythmic alternation of fine-grained sandstone, silt shale, and clay shale. This alternation is not well developed in the formation along the Okpikruak River, although there is a suggestion of it.

The pelecypod *Aucella crassicolis* Keyserling,⁵ which is characteristic of early lower Cretaceous (Neocomian) is found throughout this formation in the area of the type locality. The ammonite *Lytoceras* sp. has also been collected in the Siksikpuk River area. In the Nimiuktuk-Kugurok Rivers area on the south side of the De Long Mountains *Aucella okensis* Pavlow and *Aucella crassa* Pavlow have been collected. These

⁵ Identification of macrofossils from the Okpikruak and Torok formations have been made by Dr. Ralph W. Imlay.

forms are characteristic of the very earliest Lower Cretaceous and would presumably mark a zone lower than that of *Aucella crassicollis* Keyserling.

TOROK FORMATION (NEW)

The type locality of the Torok formation (new) is Torok Creek, a tributary to the Chandler River in the vicinity of Castle Mountain. At Castle Mountain the Torok formation in the lower part comprises 2,000 feet of dark silt and clay shale with limestone concretions, and in the upper part about 8,500 feet of dark shale and marine conglomerate and sandstone of gray-wacke type. In exposures on the Chandler and Kıruktagiak Rivers, in the vicinity of Tuktū Bluff about 11 miles north of Castle Mountain, the Torok formation in the upper part consists of 4,500 feet of dark clay and silt shale, which includes 500 feet of sandstone and some conglomerate, and in the lower part, of 1,500 feet of dark silt and clay shale. Thus at Tuktū Bluff the Torok formation is 6,000 feet thick as compared with 10,500 feet at Castle Mountain.

The Torok formation is widely exposed in an east-west belt in the Southern Foothills section of the Arctic Foothills province. This belt is characterized topographically by irregular, isolated hills and ridges of sandstone and conglomerate, which rise above low-lying areas of little relief developed on the shale. Structurally, many of these isolated hills, such as Castle Mountain and Fortress Mountain, are synclines. At most places the Torok formation overlies the Okpikruak formation, but at one place has been found overlying Triassic rocks, indicating warping and erosion of the Okpikruak formation and Jurassic rocks in post-Okpikruak time. The degree of angular unconformity is unknown, as the contact is poorly exposed.

The fauna of the Torok formation is very scarce but includes some characteristic Aptian and early Albian forms. There are a few species of *Inoceramus*, *Beudanticeras* sp., *Cleoniceras* sp., *Lemuroceras* sp., *Lemuroceras* cf. *L. belli* McLearn, *Lemuroceras* cf. *L. aburensis* Spath, and *Aucellina* cf. *A. dowlingi*. The ammonite *Cleoniceras* sp. also ranges into the overlying Tuktū

TABLE 1.—COMPARISON OF PAST AND PRESENT STRATIGRAPHIC NOMENCLATURE OF THE CRETACEOUS AND TERTIARY OF NORTHERN ALASKA

Schrader, 1902	Smith and Mertie, 1930	Gryc, Patton, and Payne, 1951				
Goobic (Gubik) sands	Quaternary	Quaternary	Gubik formation			
Tertiary Colville series	Tertiary		Tertiary	Sagavanirktok formation*		
		Cretaceous		Upper	Colville group	Prince Creek formation (nonmarine)
Upper Cretaceous Nanushuk series	Upper Cretaceous series		Lower ?		Nanushuk group	Chandler formation (nonmarine)
Lower Cretaceous Anaktovuk (Anaktuvuk) series	Lower Cretaceous series		Lower	Torok formation		
			Okpikruak formation			

* Sagavanirktok formation is not equivalent to rocks previously called Tertiary and is not believed to be present in areas studied before 1944.

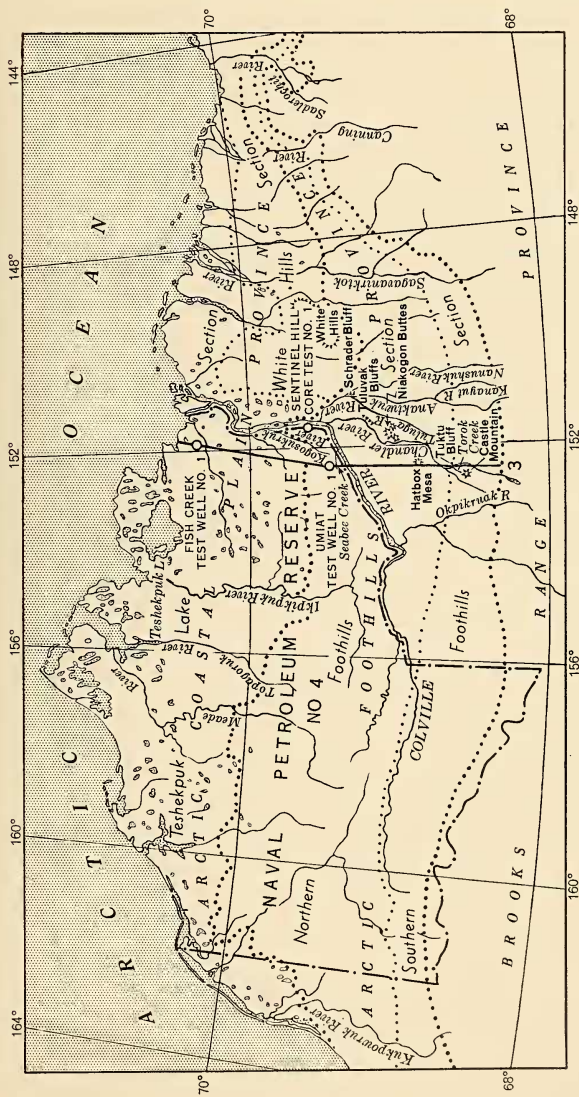


FIG. 1.—Index map of northern Alaska showing location of Fig. 3.

member of the Umiat formation. Arenaceous Foraminifera dominate the microfaunal assemblage.

Lower Cretaceous and Lower (?) Cretaceous

NANUSHUK GROUP (REDEFINED)

The Nanushuk "series" was named by Schrader⁶ from the Nanushuk River which joins the Anaktuvuk River at about the midpoint of the type section. The type section was described by Schrader as the belt of rocks beginning 5 miles north of the junction of the Colville and Anaktuvuk Rivers and extending south for 30 miles. These rocks were described as sandstone, limestone, shale, quartzite, chert, black slate, and coal. Schrader⁷ states that the series is best exposed "in the north (northeast) bank of the Anaktuvuk about 5 miles above the mouth of Tuluga River." This exposure is redescribed here as the type locality of the Schrader Bluff formation (new) of the Colville group (redefined). It is now apparent that rocks described by Schrader as the Nanushuk "series" of Upper Cretaceous age included beds of both Upper and Lower Cretaceous age and possibly older.

The name Nanushuk is here applied to a group of rocks of Lower Cretaceous and Lower (?) Cretaceous age. These are exposed along the Nanushuk River where the river cuts across the Arctic Foothills province of northern Alaska. Rocks of this group are known to crop out throughout the foothills north of the Brooks Range from the Sagavanirktok River west as far as the Kukpowruk River. The contact between the Nanushuk group and the Torok formation is believed to be gradational, but the contact zone generally is not well exposed because of the nonresistant nature of the Torok formation. In the Nanushuk River area the Torok formation appears to dip regionally more steeply than the Nanushuk group, but this is apparently due to a difference in competence. In the Kukpowruk River area the contact appears to be lithologically gradational.

The Nanushuk group includes shale, sandstone, conglomerate, and coal beds with little or no bentonite or tuff. It is estimated to be 5,750 feet thick in the outcrop area, but it thins slightly northward. Nonmarine and marine sedimentary rocks intertongue, as a result of re-

peated marine transgressions and regressions in Nanushuk time. Thus the Nanushuk group includes two intertonguing formations—the Chandler (nonmarine), which tongues into the Umiat (marine) to the north. Fig. 3 shows the relationship of the formations, members, and tongues.

Umiat formation (new).—The Umiat formation of the Nanushuk group is named from the marine part of the section below 750 feet in Umiat Test Well No. 1. (See Fig. 3.) In the vicinity of Umiat the inshore facies of the formation consists of relatively clean sandstone that grades northeast through argillaceous sandstone into shale of the offshore facies. The formation is estimated to be about 5,000 feet thick; the lower part is marine shale similar to shale of the Torok formation, which it overlies. Its fauna is almost exclusively mollusks and arenaceous Foraminifera. The lower part of the Umiat formation is Lower Cretaceous (mid-Albian), as determined from the scarce but distinctive mollusks. The upper part of the Umiat formation is probably also Lower Cretaceous (upper Albian), but the fossil data are inconclusive. The Foraminifera show a marked resemblance to those of the Ashville formation of Canada. The Umiat formation has been divided into two members—the Tuktuk and the Topagoruk.

The Tuktuk member is the basal member of the Umiat formation. Its type locality is on the Chandler River where this river cuts through Tuktuk Bluff, a continuous south-facing escarpment that can be traced for many miles. At the type locality the member is about 1,000 feet thick and underlies the Hatbox tongue of the Chandler formation (see below). Here it consists almost entirely of marine sandstone. Northward from Tuktuk Bluff to Umiat the member thickens progressively to about 2,500 feet and includes part of the marine equivalent of the Hatbox tongue of the Chandler formation, as this tongue changes to a marine facies. The characteristic fossil is an undescribed Lower Cretaceous *Inoceramus*. The ammonite *Cleoniceras* ranges from the Torok formation into the Tuktuk member of the Umiat formation. The base of the Tuktuk member coincides with the base of the Umiat formation and the base of the Nanushuk group.

The Topagoruk member of the Umiat formation is named from the section in Topagoruk Test Well No. 1, from 50 to about 3,100 feet. The top 1,000 feet includes nonmarine units of the Niakogon tongue of the Chandler formation and

⁶ SCHRADER, F. C., *A reconnaissance in northern Alaska*. U. S. Geol. Surv. Pap. 20: 79. 1904.

⁷ SCHRADER, F. C., *Idem*.

consists of coal, shale, sandstone, and minor amounts of ironstone. The bottom 2,100 feet is entirely marine clay shale, silt shale, silt, and sandstone. Fossils found in this member are Foraminifera, the scaphopod *Laevidentalium*, and *Inoceramus* prisms. It is suggested that these fossils are of Lower Cretaceous age but this is

not definitely established. The Topagoruk member thickens southward and intertongues with the Hatbox and Niakogon tongues of the Chandler formation. In much of the outcrop belt the Topagoruk member is represented by a marine sandstone which contains a diagnostic undescribed *Inoceramus* and other pelecypods.

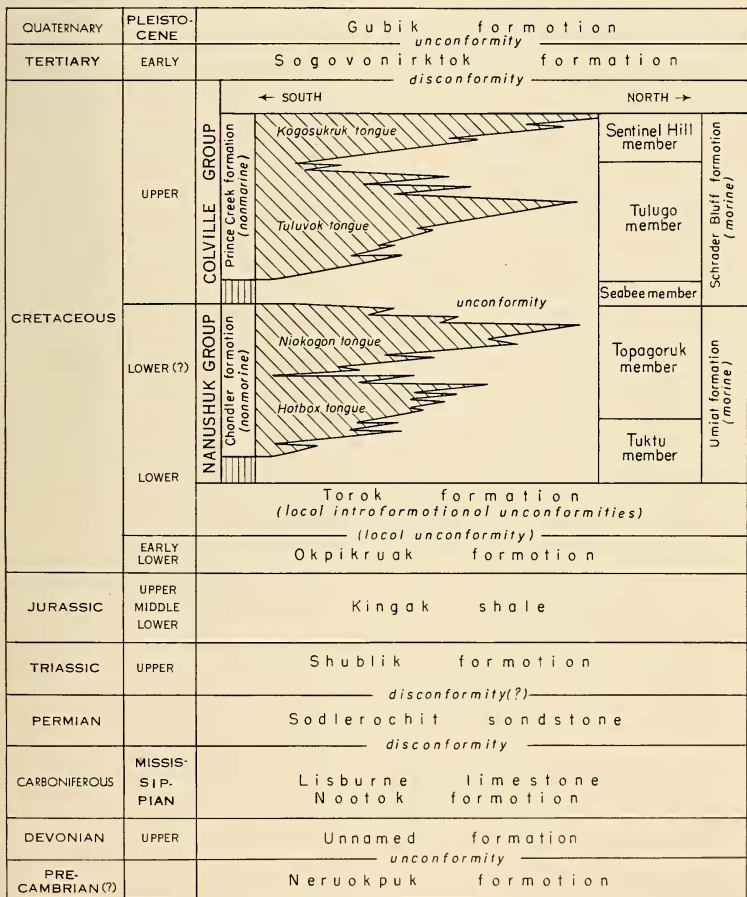


FIG. 2.—Diagrammatic columnar section of the Arctic slope of northern Alaska.

Chandler formation (new).—The Chandler formation (nonmarine) is exposed in the Northern Foothills section of the Arctic Foothills province of northern Alaska. It is the age equivalent of the Umiat formation, with which it intertongues northward in two major tongues (named) and several minor tongues (unnamed). Its type locality is on the Chandler River where the river crosses the Northern Foothills section. Lithologically most of the formation in the southern exposures is nonmarine sandstone and conglomerate. To the north it grades into shale with interbedded sandstone and coal; it contains a few fresh- to brackish-water mollusks in its northerly exposures. Along the Chandler River the formation is about 4,700 feet thick but includes minor units of marine strata of the Umiat formation. The Chandler formation overlies the Tuktuk member of the Umiat formation in the southern part of the outcrop area.

The Hatbox tongue (new) at its type locality, Hatbox Mesa in the Chandler River drainage, is approximately 3,000 feet thick and wedges out northward. It is the lower part of the Chandler formation and lies between the marine Tuktuk and Topagoruk members of the Umiat formation.

The Niakogon tongue (new) represents the upper part of the Chandler formation. Its type locality is Niakogon Buttes, between the Chandler and Anaktuvuk Rivers. In the southern part of its outcrop area it is about 1,700 feet thick; it wedges out northward. A persistent conglomerate bed, characterized by a greater percentage of white quartz pebbles than is found in other conglomerates in the region, forms the top bed of the Niakogon tongue.

Upper Cretaceous

COLVILLE GROUP (REDEFINED)

The Colville "series" was named by Schrader from exposures along the Colville River north of the junction with the Anaktuvuk River. On the basis of lithology and scanty floral evidence Schrader⁸ concluded that these rocks were of Tertiary age. Smith and Mertie⁹ concluded that "from the fossil evidence obtained in the apparent continuation of these rocks farther west" the lower part of the Colville "series" was of Upper Cretaceous age. It is now evident from

microfaunal and macrofaunal evidence that these rocks are all of Upper Cretaceous age. The exposure on the west side of the Colville River 1 mile north of the 70th parallel was considered to be Tertiary by Smith and Mertie¹⁰. It is now believed that this exposure is of the same age as the Gubik formation, which is Pleistocene. This is apparently substantiated by the lack of any Tertiary beds in the many core tests and test wells in the Barrow-Simpson and Fish Creek areas to the west of the Colville River.

The Colville series is here redefined as the Colville group, applied to type exposures along the Colville River from approximately the junction with Prince Creek east and north to the 70th parallel. Rocks of this group are well exposed in river cuts; on the Colville River these cuts form bluffs that are nearly continuous from Umiat north to Ocean Point. These rocks extend west to about the longitude of the Ikkipuk River and east to the Canning River, and perhaps beyond.

The Colville group is separated from the underlying Nanushuk group by a major unconformity. Rocks of lower Upper Cretaceous age (Cenomanian) appear to be missing. Beds of middle Upper Cretaceous age (Turonian) in the Colville group overlie beds of probable uppermost Lower Cretaceous age (Albian) in the Nanushuk group. The basal member of the Colville group is a distinctive unit consisting of black shale with limestone interbeds that can be readily identified in the field. The Colville group is divided into the nonmarine Prince Creek formation and the marine Schrader Bluff formation, which are approximately of equivalent age. In most of the outcrop belt the two formations intertongue and are not always readily distinguishable.

Lithologically the group includes clastic rocks ranging from shale to conglomerate, limestone, low grade oil shale, and coal. The total thickness of the group is about 5,200 feet.

Schrader Bluff formation (new).—The name Schrader Bluff formation (marine) is given to exposures at Schrader Bluff on the Anaktuvuk River just south of the junction with the Tuluga River. This bluff exposes the three members of the formation in over 3,000 feet of continuous outcrop. The formation has been identified in

⁸ SCHRADER, F. C., *Op. cit.*: 81-83.

⁹ SMITH, P. S., and MERTIE, J. B., JR., *op. cit.*: 232-233.

¹⁰ SMITH, P. S., and MERTIE, J. B., JR., *op. cit.*: 235.

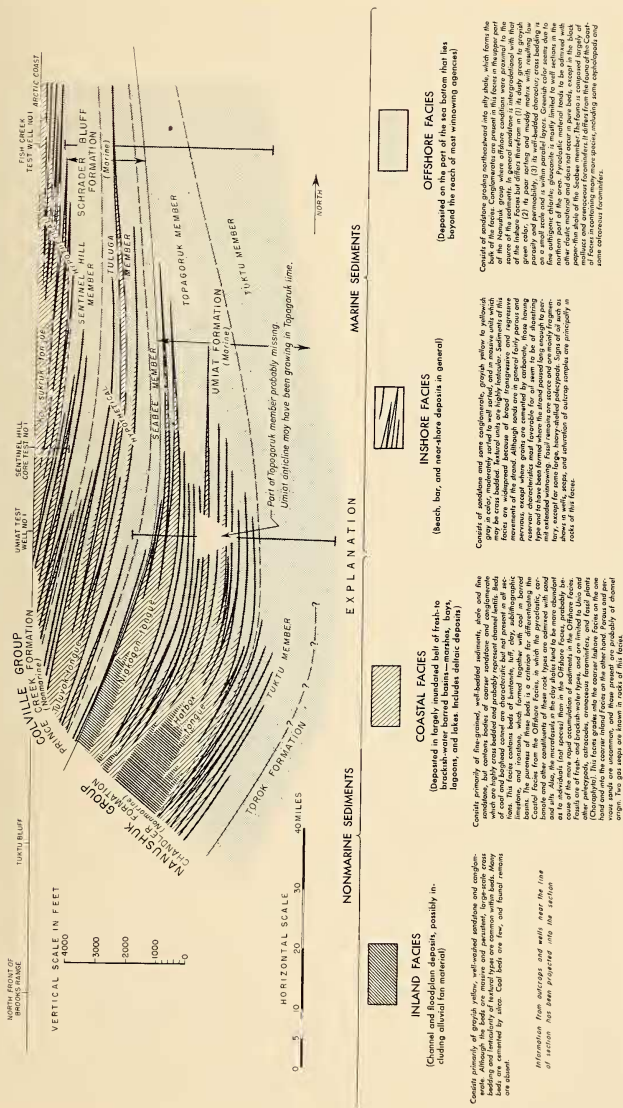


Fig. 3.—Restored facies cross section of the Nanushuk and Colville groups in northern Alaska, showing marine and nonmarine formations and their tongues and members.

well cores from the Umiat, Fish Creek, Sentinel Hill, and Cape Simpson areas. North of Umiat the Schrader Bluff formation is bounded below by the Umiat formation, and in the Umiat area and to the south by the Niakogon tongue of the Chandler formation.

Lithologically it is similar to the Umiat formation, consisting largely of marine sandstone to the south and shale to the north, but it has a much larger percentage of bentonite and tuff, which increases upward through the formation. At Fish Creek Test Well No. 1 it is 2,600 feet thick.

The Schrader Bluff formation contains more megafossils, mostly mollusks, than the Umiat formation. The characteristic megafossils are species of *Inoceramus* and *Scaphites*. Foraminifera are somewhat rarer than in the Umiat formation, but local zones of planktonic forms are present.

The Seabee member is the lowest unit of the Schrader Bluff formation. In the outcrop area it is bounded below by the Niakogon tongue of the Chandler formation. The top part of the Seabee member contains a very distinctive 150-foot unit of fossiliferous paper shale, which is a low-grade oil shale and contains a characteristic fauna. Index fossils are *Scaphites delicatulus* Warren, *Watinoceras* n. sp., *Borissjakoceras* n. sp., and *Inoceramus labiatus* Schlotheim, which indicate that this unit is the equivalent of the Greenhorn limestone of Upper Cretaceous age of the western interior United States. The member is well exposed along a tributary of the Colville River, Seabee Creek, for which it is named. It is also well exposed along Maybee Creek, a tributary of the Ikpikpuk River. The Seabee member is 450 feet thick in the type locality.

The Tuluga member is named from the Tuluga River, which enters the Anaktuvuk River at the north end of Schrader Bluff. Schrader Bluff is the best exposure of this member and is its type locality. The member is also well exposed on the Chandler River near the confluence with the Aiyiak River and on the Colville River in the Umiat area. The maximum thickness is estimated to be 2,200 feet in the outcrop belt, but this thickness includes minor units of the Tuluvak tongue of the Prince Creek formation. In Fish Creek Test Well No. 1, from 1,195 to 2,350 feet, this member is almost entirely marine except for one thin coal bed and associated sandstone.

Lithologically the Tuluga member is distinguished by abundant bentonite and tuff interbedded with a light-colored sandstone, and shale. The Tuluga member contains the largest number of individuals and species of macrofossils of any unit in the Cretaceous of northern Alaska. Fossils are commonly distributed throughout sandstone zones a few hundred feet thick. The diagnostic macrofossils are *Inoceramus lundbreckensis* McLearn and an undescribed *Scaphites*.

The Sentinel Hill member is named from the section in Sentinel Hill Core Test No. 1 in which a little over 1,100 feet of marine beds of this member and nonmarine beds of the Kogosukruk member of the Prince Creek formation were penetrated. In the outcrop belt along the Colville River equivalent intertonguing marine and nonmarine beds total 2,340 feet.

Lithologically the Sentinel Hill member is characterized by volcanic glass shards, abundant bentonite, and tuff. In outcrop the beds are less consolidated than the underlying members. Faunally this member is distinguished by abundant radiolaria, fish bones, and diagnostic Foraminifera. Macrofossils are rare and consist of long-ranging generalized types of pelecypods.

Prince Creek formation (new).—The Prince Creek formation of the Colville group includes all the nonmarine beds above the top of the Niakogon tongue of the Chandler formation and intertongues with the Schrader Bluff formation. The type locality is Prince Creek, a tributary to the Colville River. The Prince Creek formation, like the Chandler formation, is made up of sandstone, conglomerate, shale, and coal, but contains considerably more bentonite and tuff than does the Chandler formation. Its fauna consists of a few fresh- to brackish-water mollusks. The Prince Creek formation has been separated into two major tongues.

The Tuluvak tongue, the lower part of the Prince Creek formation, is best exposed in the Tuluvak Bluffs on the Chandler River where it is 1,200 feet thick. It overlies the Seabee member (marine) of the Schrader Bluff formation.

The Kogosukruk tongue is the age equivalent of the Sentinel Hill member of the Schrader Bluff formation. It is named from the Kogosukruk River, along which it is well exposed. Equally good if not better exposures which are more readily accessible are along the Colville River from near its confluence with the Anaktuvuk

River to Ocean Point just north of the 70th parallel. The total thickness along the Colville is 2,340 feet but this includes marine units of the Sentinel Hill member of the Schrader Bluff formation.

The Kogosukruk tongue is distinguished from the older units by its poor consolidation, finer texture and somewhat brighter colors. It consists largely of clay, silt, and shale. Bony coal and bentonitic beds are common. Sandstone is rare, and only one conglomerate, 15 feet thick, has been mapped. Macrofossils are very rare and consist of fresh-water and brackish-water pelecypods and gastropods.

In the outcrop belt this tongue overlies the Tuluga member of the Schrader Bluff formation and is covered by a thin mantle of the Gubik (Quaternary) formation.

TERTIARY ROCKS

Sagavanirktok formation (new)

The Sagavanirktok formation crops out in the Franklin Bluffs, its type locality, along the lower part of the Sagavanirktok River and is also well exposed in the White Hills area. It consists mainly of red-bed-type, poorly consolidated siltstone, sandstone, conglomerate, and lignite. No fauna has been found, but the formation does contain an early Tertiary flora. The Sagavanirktok formation is structurally conformable with the underlying Colville group and no large erosional break is indicated by the field data. The rocks here named the Sagavanirktok formation have not been previously mapped or described. They apparently do not crop out west of the Itkillik River and are not definitely known in the Canning River area. Thus the formation lies in an area that was unmapped and unexplored by geologists before 1944

QUATERNARY ROCKS

Pleistocene

GUBIK FORMATION

The Gubik formation of Pleistocene age mantles the older rocks in much of the Arctic Coastal Plain of northern Alaska. The name Gubik sand was first applied by Schrader¹¹ to a "surficial deposit of brownish sand or loam about 10 to 15 feet in thickness" which is exposed along the Colville River in the Coastal Plain province. The name is from the Eskimo name of the Colville River. Leffingwell¹² points out that the Eskimo name for the lower river is Kupik or "big river." Gubik, now the accepted spelling, is apparently a misspelling of Kupik.

The Gubik formation, as here redefined, ranges in thickness from a few feet to 150 feet, but in most exposures is 10 to 30 feet thick. It is largely marine and consists predominantly of loosely consolidated, cross-bedded, brown or buff gravel, sand, silt, and clay. The microfauna is somewhat similar to recent faunas and is more diversified than any of the older microfaunas of northern Alaska. The Gubik fauna differs from living Arctic faunas in that no pelagic forms have been found.

The bluffs along the west bank of the Colville River from the mouth of the Anaktuvuk River to Ocean Point expose the Gubik formation lying unconformably on the upper 1,500 feet of the Colville group. This is the original type locality as defined by Schrader¹³. A maximum thickness of 30 feet is exposed along the Colville River, but a thickness of 150 feet has been mapped on the Kikiakrorak River, 15 airline miles upstream from its confluence with the Colville River.

¹¹ SCHRADER, F. C., op. cit.: 93.

¹² LEFFINGWELL, E. DE K., *The Canning River region, northern Alaska*. U. S. Geol. Surv. Prof. Pap. 109: 95, 109. 1919.

¹³ SCHRADER, F. C., op. cit.: 93.